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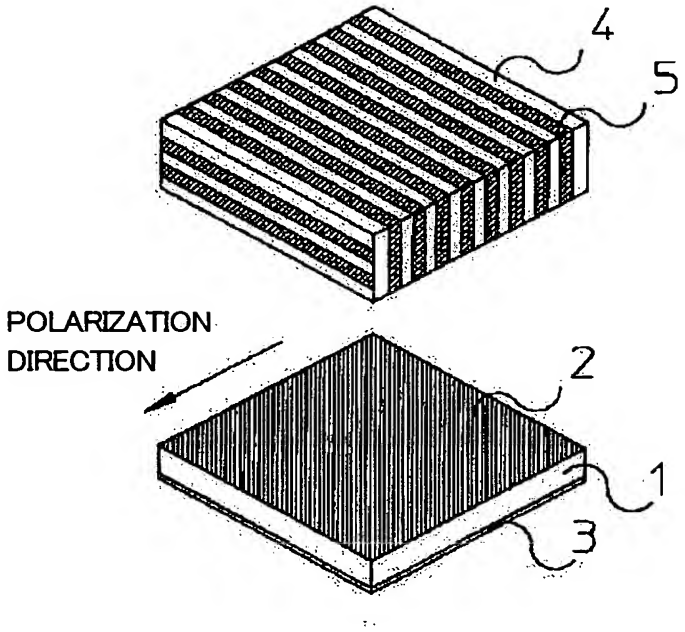
(54) [Title of the Invention] PLANAR ANTENA HAVING POLARIZATION GRID, AND ITS MANUFACTURING METHOD

(57) [Abstract]

[Problem to be solved] To provide a planar antenna having a strip grid type polarization grid capable of suppressing cross polarization of a wide angle direction and stable cross polarization, and to provide its manufacturing method.

[Solution] This planar antenna is composed of a planar antenna for emitting linear polarization and a polarization grid consisting of a plurality of strip lines arranged on a flat surface almost parallel to the opening surface of the planar antenna in the direction that directly orthogonal to the polarization direction of the planar antenna. The planar antenna is manufactured by connecting the planar antenna for emitting the linear polarization to the polarization grid through a metal wall provided at the end part of the planar antenna, or by connecting them to each other by bending a metal plate constituting the polarization grid, or by connecting them to each other by etching/removing the unnecessary portion of a conductor stuck onto an insulating base material to form metallic strip lines and connecting the strip lines to the

metal wall provided at the end part of the planar antenna for emitting the linear polarization, or by connecting them to each other by bending the metallic strip line.



[What is claimed is]

[Claim 1]

A planar antenna comprising a planar antenna for emitting a linear polarization and a polarization grid composed of a plurality of strip lines arranged in parallel to each other in a direction crossing at a right angle with a polarization direction of the planar antenna on a plane almost parallel to an opening surface of the planar antenna, wherein the planar antenna for emitting the linear polarization and the polarization grid are connected through a metal wall arranged at the end part of the planar antenna.

[Claim 2]

A planar antenna comprising a planar antenna for emitting a linear polarization and a polarization grid composed of a plurality of strip lines arranged in parallel to each other in a direction crossing at a right angle with a polarization direction of the planar antenna on a plane almost parallel to an opening surface of the planar antenna, wherein there is provided a polarization grid where the planar antenna for emitting the linear polarization and the polarization grid are connected through folding metal plate constituting the polarization grid.

[Claim 3]

A planar antenna having the polarization grid according to claim 1 or 2 in which at least two or more strip lines of a plurality of strip lines arranged in parallel to each other are short circuited.

[Claim 4]

A planar antenna having the polarization grid according to any one of claims 1 to 3 in which strip lines are formed at a rear surface of a dielectric radome.

[Claim 5]

A planar antenna having the polarization grid according to any one of claims 1 to 4 in which at least one or more strip lines of a plurality of strip lines arranged in parallel to each other is kept at the same potential as that of a ground conductor.

[Claim 6]

A planar antenna having the polarization grid according to any one of claims 1 to 5 in which a space among a plurality of strip lines arranged in parallel to each other is 0.1 times or less of a free space wavelength of electromagnetic wave emitted by the planar antenna.

[Claim 7]

A planar antenna having the polarization grid according to claim 6 in which a space width among a plurality of strip lines arranged in parallel to each other is 0.3 to 0.7 times of a space of strip lines.

[Claim 8]

A method for manufacturing a planar antenna having a polarization grid in which a unnecessary portion of conductor adhered on an insulation base material is removed through etching to form strip lines and they are connected to the metal walls arranged at the end portion of the planar antenna emitting a linear

polarization.

[Claim 9]

A method for manufacturing a planar antenna having a polarization grid by arranging metal plates in parallel to each other to form strip lines and connecting them to the metallic walls arranged at the end portions of the planar antenna for emitting a linear polarization.

[Claim 10]

A method for manufacturing a planar antenna having a polarization grid by punching out a metal plate to form strip lines and connecting them to the metal walls arranged at the end portions of the planar antenna for emitting a linear polarization.

[Claim 11]

A method for manufacturing a planar antenna having a polarization grid by adhering strip lines to the rear surface of an inductor and connecting them to the metal walls arranged at the end portions of the planar antenna for emitting a linear polarization.

[Claim 12]

A method for manufacturing a planar antenna having a polarization grid by arranging the metal plates in parallel to each other to form strip lines, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

[Claim 13]

A method for manufacturing a planar antenna having a polarization grid by punching out a metal plate to form strip lines,

folding the metal plate and connecting them to the planar antenna for emitting a linear polarization.

[Claim 14]

A method for manufacturing a planar antenna having a polarization grid by adhering strip lines of metal plates arranged in parallel to each other to the rear surface of an inductor, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

[Claim 15]

A method for manufacturing a planar antenna having a polarization grid by adhering strip lines punched out of metal plates to the rear surface of an inductor, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

This invention relates to a planar antenna having a polarization grid and its manufacturing method.

[0002]

[Prior Art]

It is well-known in the art that a strip grid type polarization grid is arranged on the upper surface of the opening surface of the planar antenna for emitting a linear polarization so as to restrict a cross polarization. As shown in Fig. 9(b), this basic

configuration is made such that the polarization grid 4 formed with a plurality of strip grids 5 crossing at a right angle with a polarization direction is arranged in parallel with the opening surface with a predetermined distance H over the opening surface 2. As this polarization grid 4, one in which the inductor base plate having a metal foil and an inductor adhered to each other is etched to form the strip grids 5 is normally applied.

[0003]

In addition, as shown in Fig. 9(a), although the polarization grid 4 is set such that a restricting effect of the cross polarization is determined by a strip grid width W and an arrangement space P of the strip grid, it is preferable that in general, the arrangement space P is set to be less than about 0.1 times of a free space wavelength of a desired frequency.

[0004]

[Problem to be Solved by the Invention]

In recent years, as data communication volume has been increased a radio system for use in communicating high density information within a short distance has been widely utilized. In such a system as above, it is necessary to arrange many antennas within a narrow range, so that their mutual interferences must be made small as much as possible. Due to this fact, a cross polarization in a wide angle direction in respect to an emitting plane is required to be restricted to a lower value than that of the prior art. However, as shown in Fig. 9(c), in the case that the polarization grid 4 was

fixed in parallel with the opening surface 2, there occurred a problem that the electromagnetic wave emitted in a shaded line direction could not be ignored and a restriction of the cross polarization in a wide angle direction was difficult. In addition, although the planar antenna 1 and the polarization grid 4 in the prior art were arranged at a predetermined distance through a spacer such as a foamed inductor and the like, there occurred a problem that a certain disturbance occurred in a restricting effect against the cross polarization due to its mechanical instability.

[0005]

It is an object of this invention to provide a planar antenna having a strip grid type polarization grid capable of restricting a cross polarization in a wide angle direction and restricting stably a cross polarization and its manufacturing method.

[0006]

[Means for Solving the Problem]

This invention has the following features.

(1) A planar antenna comprising a planar antenna for emitting a linear polarization and a polarization grid composed of a plurality of strip lines arranged in parallel to each other in a direction crossing at a right angle with a polarization direction of the planar antenna on a plane substantially in parallel with an opening surface of the planar antenna, wherein the planar antenna for emitting the linear polarization and the polarization grid are connected through a metal wall arranged at the end part of the

planar antenna.

(2) A planar antenna comprising a planar antenna for emitting a linear polarization and a polarization grid composed of a plurality of strip lines arranged in parallel to each other in a direction crossing at a right angle with a polarization direction of the planar antenna on a plane almost parallel to an opening surface of the planar antenna, wherein there is provided a polarization grid where the planar antenna for emitting the linear polarization and the polarization grid are connected through folding metal plates constituting the polarization grid.

(3) A planar antenna having the polarization grid according to (1) or (2) in which at least two or more strip lines of a plurality of strip lines arranged in parallel to each other are short circuited.

(4) A planar antenna having the polarization grid according to any one of (1) to (3) in which strip lines are formed at a rear surface of a dielectric radome.

(5) A planar antenna having the polarization grid according to any one of (1) to (4) in which at least one or more strip lines of a plurality of strip lines arranged in parallel to each other is kept at the same potential as that of a ground conductor.

(6) A planar antenna having the polarization grid according to any one of (1) to (5) in which a space among a plurality of strip lines arranged in parallel to each other is 0.1 times or less of a free space wavelength of electromagnetic wave emitted by the planar antenna.

(7) A planar antenna having the polarization grid according to (6) in which a space width among a plurality of strip lines arranged in parallel to each other is 0.3 to 0.7 times of a space of strip lines.

(8) A method for manufacturing a planar antenna having a polarization grid in which an unnecessary portion of conductor adhered on an insulation base material is removed through etching to form strip lines and they are connected to the metal walls arranged at the end portions of the planar antenna emitting a linear polarization.

(9) A method for manufacturing a planar antenna having a polarization grid by arranging metal plates in parallel to each other to form strip lines and connecting them to the metal walls arranged at the end portions of the planar antenna for emitting a linear polarization.

(10) A method for manufacturing a planar antenna having a polarization grid by punching out a metal plate to form strip lines and connecting them to the metal walls arranged at the end portions of the planar antenna for emitting a linear polarization.

(11) A method for manufacturing a planar antenna having a polarization grid by adhering strip lines to the rear surface of an inductor and connecting them to the metal walls arranged at the end portions of the planar antenna for emitting a linear polarization.

(12) A method for manufacturing a planar antenna having a polarization grid by arranging the metal plates in parallel to each

other to form strip lines, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

(13) A method for manufacturing a planar antenna having a polarization grid by punching out a metal plate to form strip lines, folding the metal plate and connecting them to the planar antenna for emitting a linear polarization.

(14) A method for manufacturing a planar antenna having a polarization grid by adhering strip lines of metal plates arranged in parallel to each other to the rear surface of an inductor, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

(15) A method for manufacturing a planar antenna having a polarization grid by adhering strip lines punched out of metal plates to the rear surface of an inductor, folding the metal plates and connecting them to the planar antenna for emitting a linear polarization.

[0007]

[Preferred Embodiments of the Invention]

In Fig. 1, there is provided a polarization grid 4 forming a plurality of strip grids 5 held almost parallel from the opening surface 2 of the planar antenna 1 for emitting a linear polarization and crossing at a right angle in a polarization direction of the planar antenna 1 characterized in that the strip grid 5 is formed in continuous with an emitting area including a ground conductor 3 of the planar antenna 1 and a ground surface of

the same potential.

[0006]

In Figs. 2(a), (b), there is provided the polarization grid 4 almost held in parallel from the opening surface 2 of the planar antennal for emitting a linear polarization and formed with a plurality of strip grids 5 crossing at a right angle with a polarization direction of the planar antenna 1 characterized in that the strip grids 5 are formed in continuous with an emitting region including the ground conductor 3 of the planar antenna 1 and the ground surface of the same potential within one plane of either a plane in the polarization direction of the planar antenna 1 or a plane crossing at a right angle with the former one.

[0007]

In Fig. 3, this invention is characterized in that the metal conductor 6 for making the strip grids conductive is arranged within a part of the emitting region or entire region including an end part of a region positioned at the upper part of the opening surface 2 of the planar antenna 1 for emitting the linear polarization and the ground surface having the same potential as that of the ground conductor 3 of the planar antenna 1.

[0008]

In Figs. 9(a), (b), this invention is characterized in that a period P of the strip grids is less than 0.1 times of a free space wavelength, a strip grid width is almost 0.5 times of the period and a distance H against the emitting surface 2 fulfills a value of

more than 0.1 times of the free space wavelength.

[0009]

In Figs. 4(a), (b), this invention is characterized in that the polarization grid 4 is formed with a flexible base plate having the strip grid 5 formed through etching and at the same time in order to hold a predetermined distance, the metal wall 7 arranged in a side surface direction of the opening surface 2 is used to cause the flexible base plate to be fixed to the ground surface of the same potential as that of the conductor.

[0010]

In Figs. 6(a), (b), this invention is characterized in that the polarization grid 4 is formed with the metal plate 8 having the strip grid 5 formed through punching or etching and at the same time the end part of the metal plate 8 is bent only by a predetermined distance and fixed to the ground of the same potential as that of the ground conductor 3.

[0011]

In Figs. 7(a), (b), this invention is characterized in that the polarization grid 4 is formed with the flexible base plate having the strip grid 5 formed through etching and at the same time in order to hold a predetermined distance both conductor or inductor guide 9 arranged in a side surface direction of the opening surface 2 and the fixed plate 10 are used for fixing the flexible base plate at the ground surface having the same potential as that of the conductor.

[0012]

In Figs. 8(a), (b), this invention is characterized in that the polarization grid 4 is formed by a metal plate having the strip grid 5 formed through punching or etching or a flexible base plate having the strip grid 5 formed through etching and at the same time, the polarization grid 4 is integrally closely contacted to the inside part of the dielectric radome 11.

[0013]

The polarization grid 4 of this invention is manufactured by removing unnecessary portions through etching of a flexible base plate having a copper foil adhered to a polyimide base material or punching or etching of a thin metal plate. The polarization grid 4 has a superior flexibility, so that this material can be used while it is adhered to the inner surface of the radome or folded. Further, since the polarization grid 4 is required to be fixed in parallel to the emitting surface 1 under a stable condition, it is necessary that the metal wall 7 and the guide 9 have a high precision and certain hardness not producing any deformation. In addition, although it is preferable that the metal wall 7 is made of aluminum for its light weight formation, this wall can also be manufactured by other metals.

[0014]

[Preferred Embodiments]

Preferred Embodiment 1

In Fig. 1, the polarization grid 4 formed with a plurality of

strip grids 5 through etching of the flexible base plate having copper foil adhered to a polyimide base material was arranged at the upper part or the side part of the opening surface 2 of a triplate power feeding planar antenna for emitting linear polarization. A method for fixing the flexible base plate is carried out in accordance with a preferred embodiment 7.

[0015]

Preferred Embodiment 2

In Figs. 2(a), (b), the polarization grid 4 formed with a plurality of strip grids 5 through etching of the flexible base plate having a copper foil adhered to a polyimide base material was arranged at the upper part of the opening surface 2 of a tri-plate power feeding planar antenna for emitting linear polarization and in either the plane of polarization direction or one side surface or the plane crossing at a right angle with the former plane. A method for fixing the flexible base plate is carried out in accordance with a preferred embodiment 6.

[0016]

Preferred Embodiment 3

In Fig. 3, the metal plate 8 having both the strip grid 5 formed through etching and the metal conductor 6 was arranged at the upper part of the opening surface 2 of a triplate power feeding planar antenna 1 for emitting linear polarization and its side surface. A method for fixing the metal plate 3 is carried out in accordance with a preferred embodiment 5.

[0017]

Preferred Embodiment 4

In Figs. 4(a), (b), the metal wall 7 made of aluminum was arranged at the side surface of the opening surface 2 of the triplate type power feeding planar antenna 1 for emitting a linear polarization, the polarization grid 4 having a plurality of strip grids 5 formed through etching of the flexible base plate with copper foil adhered to a polyimide base material was fixed in a substantial parallel state from the opening surface.

[0018]

Figs. 5(a), (b) are views for illustrating a restricting effect of the cross polarization. Fig. 5(a) shows a case in which the polarization grids are not present and Fig. 5(b) shows the cross polarization under a case in which the polarization grids are present. With such an arrangement as above, it was confirmed that the cross polarization can be substantially improved with the polarization grids.

[0019]

Preferred Embodiment 5

In Figs. 6(a), (b), the copper metal plate 8 having strip grids 5 formed through etching was arranged at the upper part and side surfaces of the opening surface 2 of the triplate power feeding type planar antenna 1 for emitting a linear polarization. In addition, the end part of the metal plate 8 was bent only for a predetermined distance and the metal plate was fixed almost in

parallel from the opening surface 2.

[0020]

Preferred Embodiment 6

In Figs. 7(a),(b), the guide 9 made of ABS and the aluminum fixed plate 10 were arranged at the side surface of the opening surface 2 of the triplate power feeding type planar antenna 1 for emitting a linear polarization and the flexible base plate having copper foil adhered to the polyimide base member was processed with etching, thereby the polarization grid 4 formed with a plurality of strip grids 5 was fixed almost in parallel from the opening surface.

[0021]

Preferred Embodiment 7

In Figs. 8(a), (b), the dielectric radome 11 made of ABS with a thickness of 3 mm was arranged at the upper part and the side surface of the opening surface 2 of the triplate power feeding type planar antenna 1 for emitting a linear polarization, the polarization grid 2 formed with a plurality of strip grids 5 by etching the flexible base plate having copper coil adhered to the polyimide base member was integrally adhered to the inside part of the radome 11.

[0022]

In addition, in the preferred embodiments 1 to 7, each of the sizes of the grids satisfies that a slit period P in Figs. 9(a), (b) is less than 0.1 times of a free space wavelength, a slit width L is about 0.5 times of the period P and a distance H from the

emitting surface is more than 0.1 times of the free space wavelength.

[0023]

[Effects of the Invention]

In accordance with this invention, this invention enabled the strip grid type polarization grid to be realized in which the cross polarization in a wide angle direction and a stable restriction over the cross polarization can be carried out.

[Brief Description of the Drawings]

[Fig. 1] This is an exploded perspective view for showing the preferred embodiment 1 of this invention.

[Fig. 2] This is an exploded perspective view for showing the preferred embodiment 2 of this invention.

[Fig. 3] This is an exploded perspective view for showing the preferred embodiment 3 of this invention.

[Fig. 4] This is an exploded perspective view and a side elevation view for showing the preferred embodiment 4 of this invention.

[Fig. 5] This is a graph for illustrating an effect of this invention.

[Fig. 6] This is an exploded perspective view and a side elevation view for showing the preferred embodiment 5 of this invention.

[Fig.7] This is an exploded perspective view and a side elevation view for showing the preferred embodiment 6 of this invention.

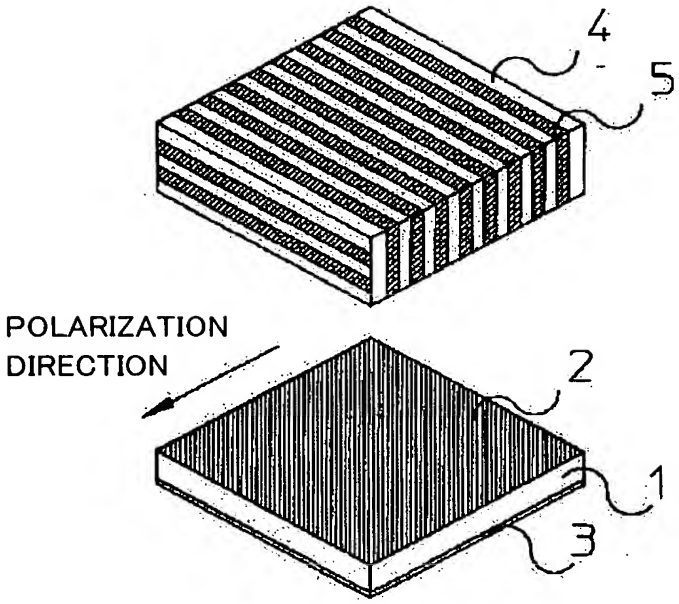
[Fig. 8] This is an exploded perspective view and a side elevation view for showing the preferred embodiment 7 of this invention.

[Fig. 9] This is an exploded perspective view, a front elevation view and a side elevation view for showing the prior art.

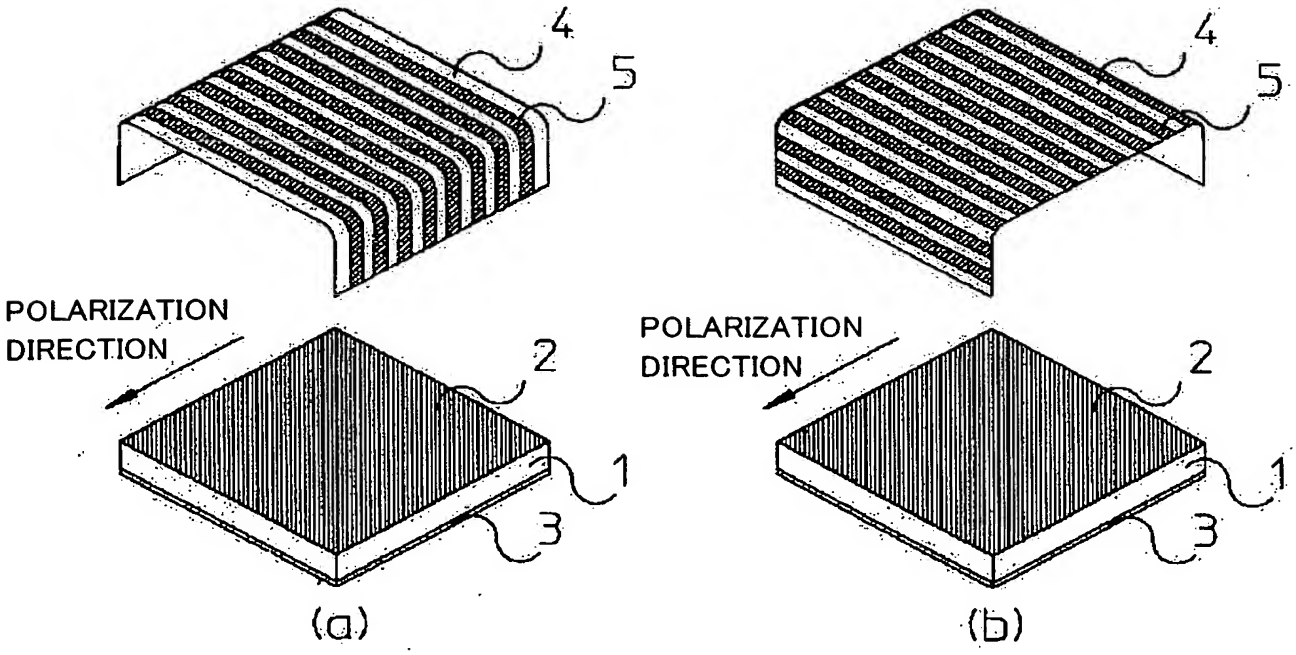
[Description of the Reference Numerals]

1. Planar antenna
2. Opening surface
3. Ground conductor
4. Polarization grid
5. Strip grid
6. Metallic conductor
7. Metal wall
8. Metal plate
9. Guide
10. Fixed plate
11. Dielectric radome

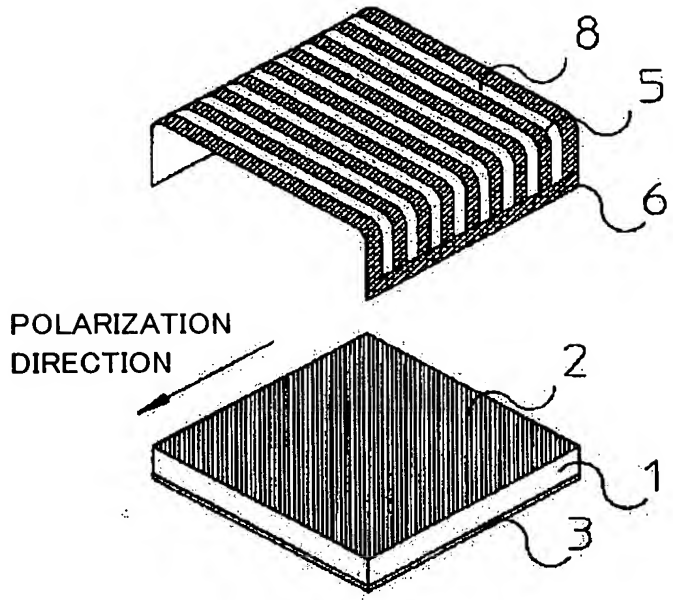
[Fig. 1]


4
5
POLARIZATION
DIRECTION
2
1
3

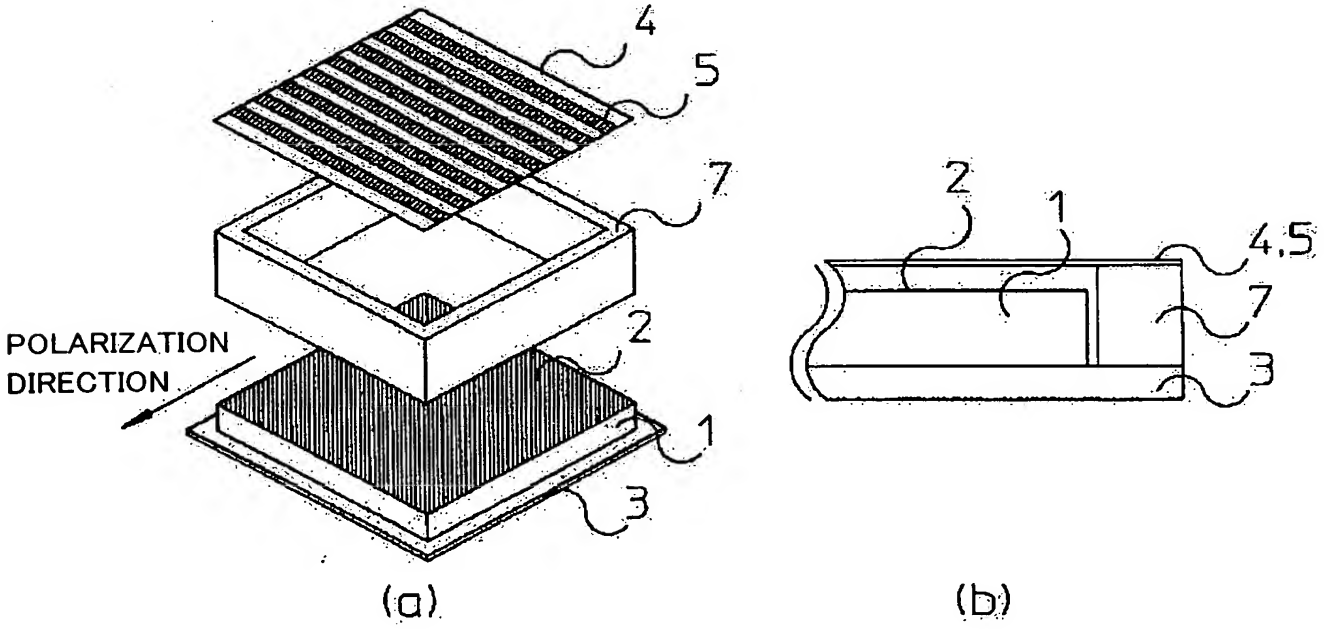
[Fig. 2]


4
5
POLARIZATION
DIRECTION
2
1
3
(a)
4
5
POLARIZATION
DIRECTION
2
1
3
(b)

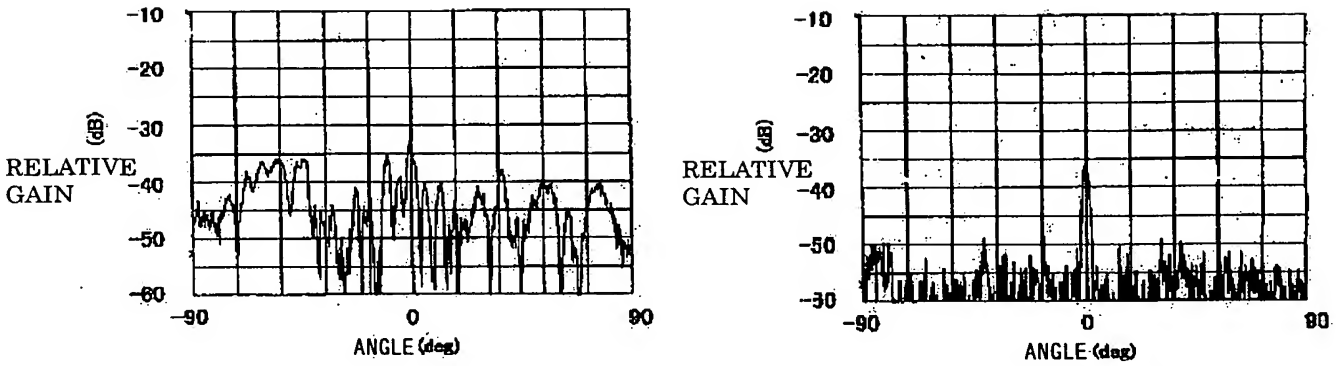
[Fig. 3]


8
5
6
POLARIZATION
DIRECTION
2
1
3

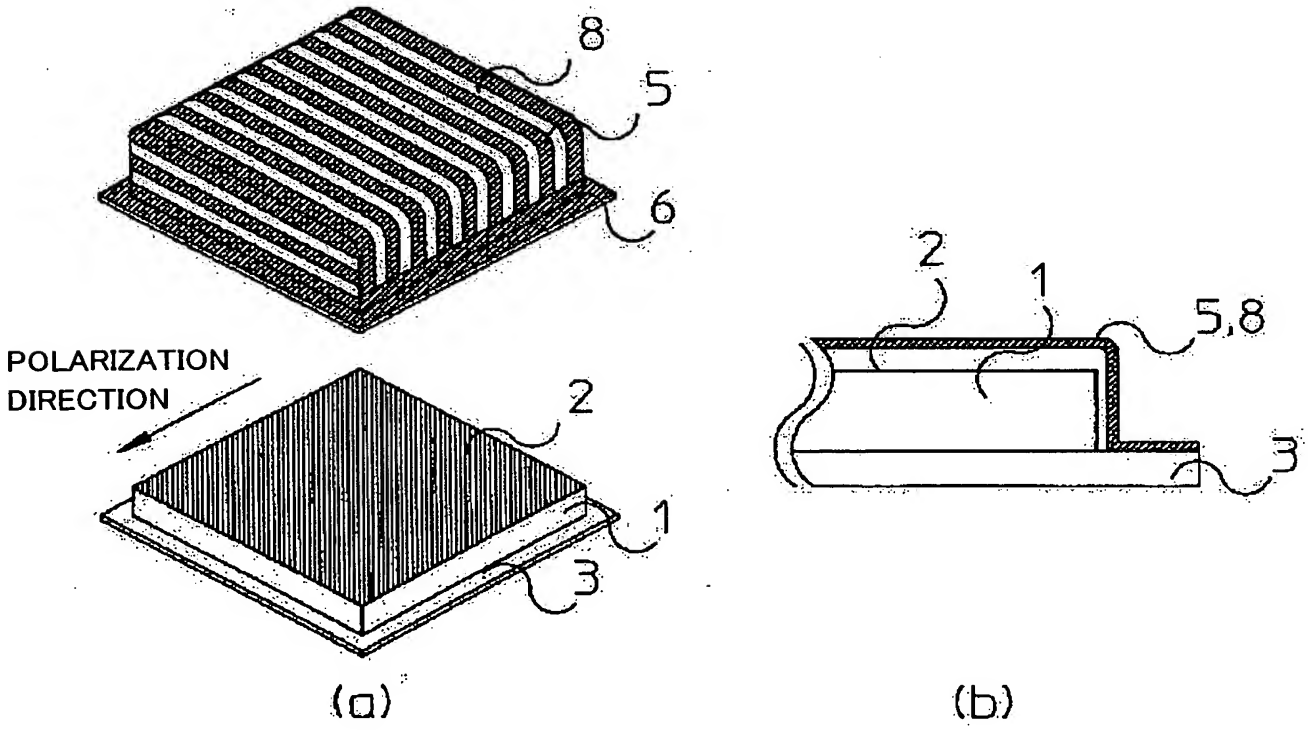
[Fig. 4]


4
5
7
POLARIZATION
DIRECTION
2
1
3
(a)
2
1
4,5
7
3
(b)

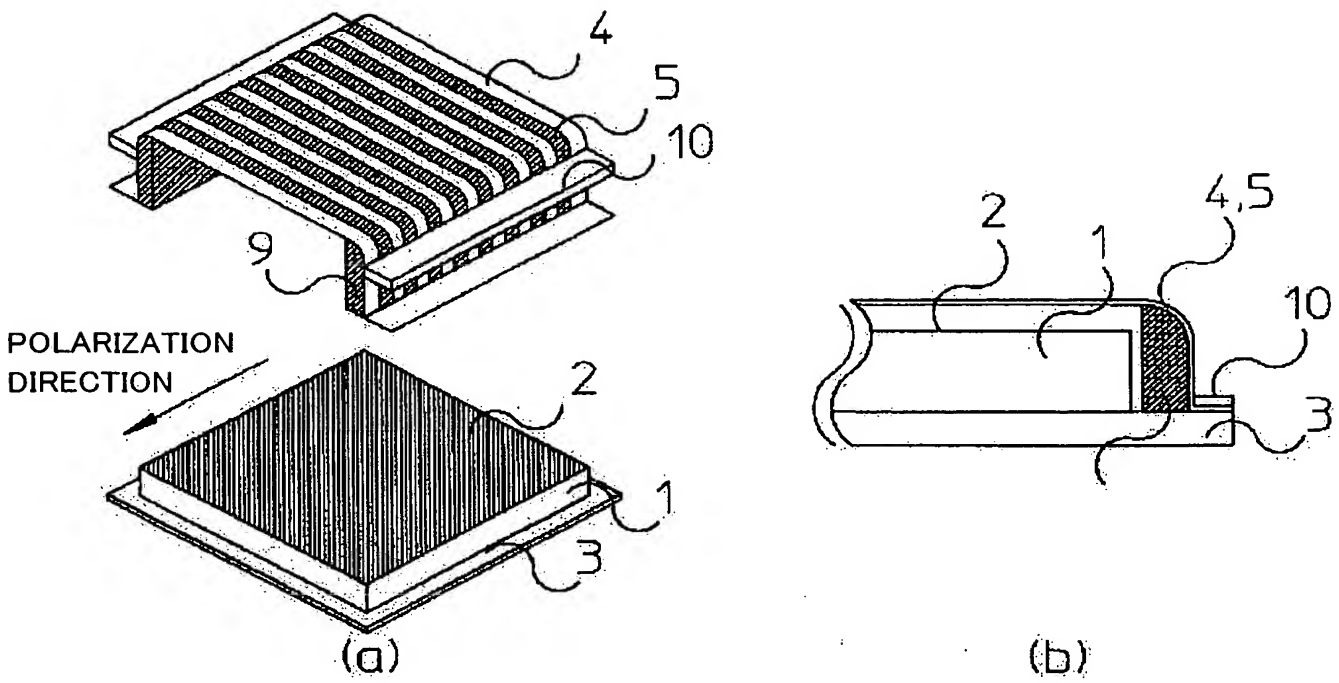
[Fig. 5]


RELATIVE GAIN
(dB)
-10
-20
-30
-40
-50
-60
-90
0
90
ANGLE (deg)
(a)
RELATIVE GAIN
(dB)
-10
-20
-30
-40
-50
-90
0
90
ANGLE (deg)
(b)

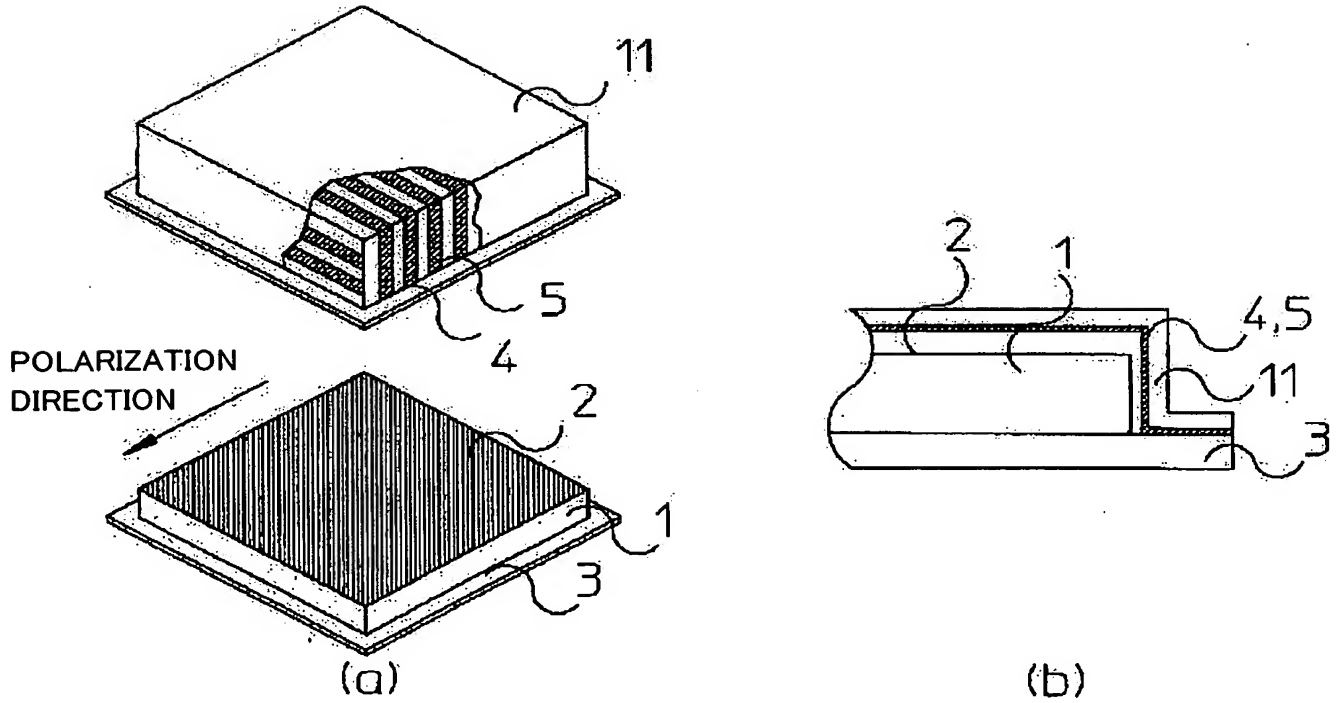
[Fig. 6]


8
5
6
POLARIZATION DIRECTION
2
1
3
(a)
2
1
5,8
3
(b)

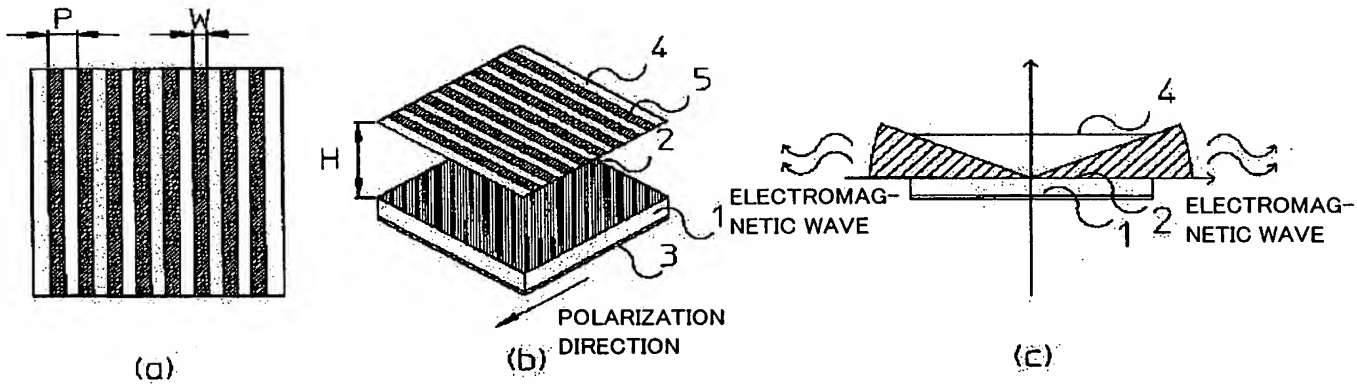
[Fig. 7]


4
5
10
9
POLARIZATION
DIRECTION
2
1
3
(a)
4,5
2
1
10
3
(b)

[Fig. 8]


11
5
4
POLARIZATION
DIRECTION
2
1
3
(a)
2
1
4,5
11
3
(b)

[Fig. 9]


P
W
(a)
4
5
2
H
1
3
POLARIZATION DIRECTION
(b)
4
ELECTROMAG-NETIC WAVE
1
2
ELECTROMAG-NETIC WAVE
(c)